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## THE BELLOWS (SYLPHON) FUEL PUMP FOR LIBERTY "12" AND WRIGHT MODEL "H" ENGINES

(Supersedes Report of April 28, 1921, Entitled "The Sylphon  
Fuel Pump," and Published in Information Circular No. 281)

(POWER PLANT SECTION REPORT)



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**CERTIFICATE:** By direction of the Secretary of War, the matter contained herein is published as administrative information and is required for the proper transaction of the public business.

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# THE BELLOWS (SYLPHON) FUEL PUMP FOR LIBERTY "12" AND WRIGHT MODEL "H" ENGINES.

## DESCRIPTION OF AND INSTRUCTIONS CONCERNING THE LIBERTY "12" AND WRIGHT "H" MODELS.

### GENERAL.

It was advisable to change the name of this pump from "Sylphon fuel pump" to "Bellows Fuel Pump" because of the fact that the term "Sylphon" is a trade name for the first make of copper bellows used. Another make of bellows has also been found by test to be satisfactory for this work.

The bellows pump was designed to fill the need for an engine-driven fuel pump in order to obviate the use of air pressure where sufficient gravity head is not available. The name is derived from the metallic bellows, which is the characteristic feature of this pump. This type of pump was selected because it requires no packing gland and also because it gives a fixed maximum discharge pressure at high speeds and sufficient fuel at any speed, thus doing away with a relief valve. It is built in duplex form, so that in case one pumping unit fails the other unit will maintain sufficient fuel supply for all engine speeds.

Over two years of service of this type in flight and a 1,400-hour bench test at full capacity have shown this pump to be highly reliable. This performance, however, can be expected only when proper care, which is due any mechanism of this nature, is maintained.

At present this pump is produced for use on the Liberty "12" and Wright model "H" engines. The only difference between the two models is in the drive shaft and base casting flange. The assembly drawing number of the Liberty "12" pump is 047280 and that of the Wright model "H" is 047281.

### GENERAL DESCRIPTION.

The Liberty "12" pump will be described, but the description for the model "H" is the same except that the splined drive shaft (045289) and the base casting (045266) on the Liberty are replaced on the model "H" by parts Nos. 045280 and 045267 respectively. The nut on the end of the magneto drive shaft of the model "H" must be removed and replaced by nut (045458) which is furnished with the pump. The Liberty pump is driven directly from the crank shaft.

A four-pitch worm (045205) in Figure 1 meshes with a 32-tooth worm wheel (045291), giving an 8 to 1 reduction. The worm wheel is attached to a cam shaft (045284) which

actuates cam follower rollers (045287) attached to cam followers (045286). The cam followers extend into the bellows flange (045259) to which the bellows (045308) is soldered. The upper end of the bellows is soldered to the bellows head plate (045436), which is secured in position by machine screws (SP-2446). The bellows chamber (047277) also contains the inlet and outlet valve assemblies (047282) and (045276) respectively. As the worm rotates the worm wheel on the cam shaft the cams move the plungers down only, admitting fuel from the main tank to the bellows which is returned to its original position by the spring (045282) designed to give a maximum pressure of  $4\frac{1}{2}$  pounds per square inch with a closed discharge.

The worm drive shaft (045289) is threaded on to the worm and butts against the ball bearing. The worm bearing cage (045260) holds the bearing in position. The worm bearing cage retainer (045261) is grooved for felt packing to keep oil in the pump, and fits just outside of the worm bearing cage. The worm bearing cage and the worm bearing cage retainer are attached to the pump base by machine screws. The pump base cap (045302) is the bronze bearing on the other end of the worm.

The cam followers (045286) operate in the cam follower bearings lower (045304) and upper (045288), which are bronze bushings. The upper bearings are in the cam shaft support (045264) and the lower bearings in the pump base (045266). The cam shaft operates in aluminum bearings in the cam shaft support.

There are two intake and two outlet valves, each a unit, screwed into the valve chamber which is the upper part of the bellows chamber casting. The valve chamber has a partition, on one side of which are the two intake valves and on the other side the two outlet valves.

A hole, having  $\frac{1}{4}$ -inch pipe thread about one-half way down on one side of the pump, is utilized as a drain in case a gasket leaks or a bellows breaks.

Two outlets and two inlets are provided for convenience in installation. Only one of each is necessary. The pipe plugs are inserted to prevent dirt getting in valves in shipping and stocking.

The pipe plug in the bottom of the base is permanent and should be removed only to refill the base with lubricant.

## OVERHAUL.

When an engine, having a pump attached, is received at a repair depot for overhaul, this pump should undergo the following test:

*Shaft speed* for all tests between 1,700 and 1,750 revolutions per minute.

*Priming test.*—With the suction side of the pump communicating with fuel tank in which the fuel level is at least 3 feet below the inlet to the pump, the pump must prime itself within 10 seconds, the pump being entirely dry at the start of this test.

*Closed discharge test.*—With the discharge closed, the pressure shall not exceed  $4\frac{1}{2}$  pounds per square inch.

*Capacity test.*—With the discharge throttled to give a discharge pressure of 1 pound per square inch measured at the pump outlet, the capacity shall be not less than 70 gallons per hour. With a discharge pressure of 2 pounds per square inch the capacity shall not be less than 35 gallons per hour.

If the pump passes this test, it may be replaced without overhaul. In case it does not pass the test, follow the directions below under "Disassembly." The following are a few aids in locating the trouble:

If the pump leaks at the small side opening, either a bellows is broken or else a gasket (045429) between the bellows and the chamber is defective.

If there is a leak around the top screws, it is probably due to a defective gasket (045429) between the bellows and the chamber or to a scratched or warped surface of the bellows head.

If the pump will not prime, or if it is under capacity, it may be due to a number of things: One or more of the four valves may have a chip holding it open, a plunger may not be free in its guides, or actuating spring may be weak. (See Precautions.)

## DISASSEMBLY.

To disassemble the pump, first loosen, but do not remove, screws (SP-2446) on the top of the bellows chamber.

Remove screws which join bellows chamber, cam shaft support (045264), and pump base (045266).

Tap lightly on upper screws (SP-2446) until bond between gasket (045429) and bellows chamber is broken. (This prevents bellows from being stretched.)

Lift off bellows chamber (045277).

Carefully lift off cam shaft support (045264). This part carries the worm wheel and is doweled onto pump base (045266), giving correct alignment with worm (045305).

The worm wheel is removed by unscrewing machine screws (SV-2533).

The worm (045305) can be removed by withdrawing cotter on engine shaft (045289), unscrewing same, pulling

worm bearing cage retainer (045261), worm bearing cage (045260), and ball bearing, then removing worm (045305).

The cam follower bearings upper (045288) and lower (045304), the pump base cap (045302), and worm bearing cage (045260) are of bronze, pressed in.

The four valve assemblies are in units. These can be removed by means of a broad screw driver or socket wrench

## INSTALLATION.

The Liberty "12" pump has a splined drive which fits into the rear end of the crank shaft. It is attached by nuts holding it down to six studs on the rear of the crank case. Figure 2 shows this pump mounted.

The Wright model "H" pump has a square drive which fits into a special nut which replaces nut (11240) on the end of the magneto drive gear shaft (13127). It is attached to the rear end of the magneto bracket. Figure 3 shows this pump mounted.

Either "in" and either "out" may be used in piping these pumps. The "in" and "out" not used must be plugged. Care must be taken not to get dirt into the valve chamber when this work is done.

The  $\frac{1}{4}$ -inch P. T. tapped hole about halfway down on one side should be piped through the bottom of the fuselage. This acts as a drain in case of gasket leak or other failure, thus reducing fire hazard, and making it less difficult to locate the trouble.

Figure 4 shows a typical piping installation using this type of pump.

## PRECAUTIONS.

Study Figure 1 and read "Disassembly" carefully before attempting disassembly. Lock all screws with wire in reassembling.

The pump base should be thoroughly cleaned of lubricant, and about one-fifth of a pound of fresh vaseline put in every 300 hours of service.

Do not use rubber for gasket material. "Siegelite" should always be used.

Do not attempt to repair a leaky bellows

If a pump is under capacity, do not force it by increasing the tension of the actuating springs. Something else is wrong which might cause future trouble.

Actuating springs must have a tension of  $12\frac{1}{2}$  pounds, plus or minus one-fourth pound, when compressed at  $1\frac{1}{4}$  inches.

In reassembling, see that bellows height from bottom of lower head to top of upper head is  $1\frac{1}{4}$  inches.

Before assembling, see that valves are clean and working properly.

In reassembling, before putting on bellows chamber, line up holes in top bellows heads, and no trouble should be experienced in threading screws into place.



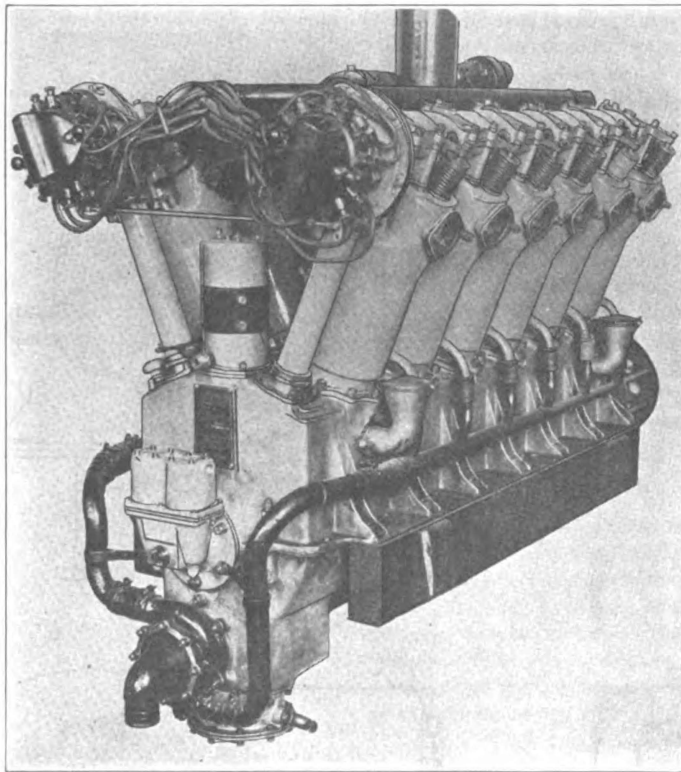


FIG. 2.—Pump on a Liberty "12" engine.

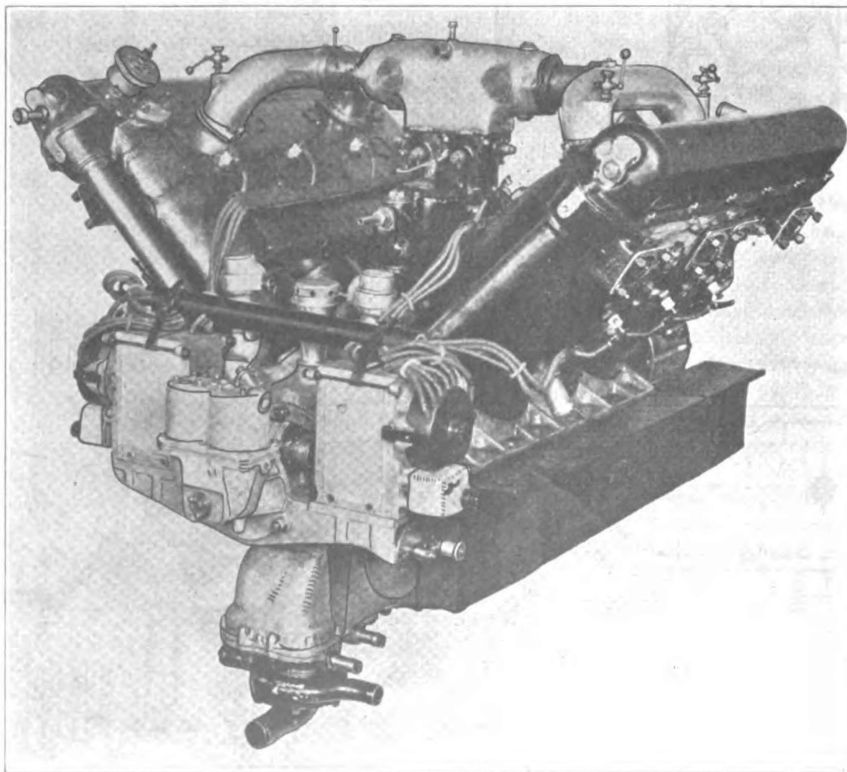
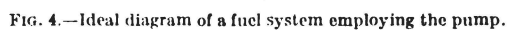


FIG. 3.—Pump on a Wright Model "H" engine.



## AIR SERVICE INFORMATION CIRCULAR.

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CHANGES  
No. 1.

WAR DEPARTMENT, AIR SERVICE,  
January 1, 1923.

Page 3, columns 1 and 2, paragraph 2, under General Description, Air Service Information Circular, Vol. IV, No. 369, "The Bellows (Sylphon) Fuel Pump for Liberty '12' and Wright Model 'H' engines," are changed, by order of the Chief of Air Service, in accordance with a recommendation of the Engineering Division contained in a letter dated November 7, 1922, as follows:

*Page 3, column 1, paragraph 2, under General Description, should read as follows:*

A four-pitch worm (045305) in Figure 1 meshes with a 32-tooth worm-wheel (045291) giving an 8 to 1 reduction. The worm-wheel is attached to a cam shaft (045284) which (C. A. S. I. C. No. 1, Jan. 1, 1923.)

*Page 3, column 2, should read as follows:*

actuates cam follower rollers (045287) attached to cam followers (045286). The cam followers extend into the bellows flange (045289) to which the bellows (045308) is soldered. The upper end of the bellows is soldered to the bellows head plate (045436) which is secured in position by machine screws (SP-2446). The bellows chamber (047277) also contains the inlet and outlet valve assemblies (047282) and (047276) respectively. As the worm rotates the worm-wheel on the camshaft the cams move the plungers down only, admitting fuel from the main tank to the bellows which is returned to its original position by the spring (045282) designed to give a maximum pressure of 4½ pounds per square inch with a closed discharge. (C. A. S. I. C. No. 1, Jan. 1, 1923.)